Summary of the INTEX-B Investigation Proposed by Jennie Moody

My focus will be on the upper troposphere, the region where stratosphere/troposphere exchange (STE) plays an important role in determining tropospheric levels of ozone, and where jet stream dynamics contribute to intercontinental transport of pollutants. This proposal responds to the call for detailed investigations of the relationship between the distribution of ozone, water vapor, and temperature (as well as trace constituents) in the upper troposphere, all elements which were considered a programmatic priority.

The unique and primary products that will be provided by UVA in support of these NASA missions will be satellite derived specific humidity imagery and model runs of reverse-domain-filling (RDF) Lagrangian trajectories. These RDF runs will be employed in both prognostic and diagnostic modes to derive the evolution of relevant dynamical fields like potential vorticity and model specific humidity. The resulting products will be used to predict or characterize important processes like the filamentation and fragmentation of streamers in the upper troposphere. These features are associated with chaotic advection. We can approximate the mixing associated with these processes using Liapunov exponents; derived from the RDF technique, they provide a measure of the stretching rate, the deformation of the flow field by velocity shear that ultimately results in irreversible mixing.

The PI will provide a meteorological service to the INTEX campaign in the form of value-added operational products. These will include mixing forecasts and real-time geostationary imagery of specific humidity, a conservative quantity in the upper troposphere that provides a uniquely high spatial and temporal resolution depiction of upper tropospheric dynamics. Additionally, this proposal affords the opportunity for the PI to pursue a number of relevant, outstanding science questions regarding the detection of STE through remote sensing the location of the time-varying tropopause break and quantifying the role of STE in determining the mixing ratio of ozone in the mid-to-upper troposphere.

The PI has two specific objectives.

- ***to provide real-time GOES layer-average specific humidity (GLASH) imagery and reverse domain filling (RDF) Lagrangian trajectory mixing forecasts throughout the NASA aircraft experiments planned for the spring of 2006***, and to archive the imagery/data for post-mission analyses.
- ***to analyze data from the INTEX-B mission with an emphasis on the detection of stratosphere/troposphere exchange (STE)*** through remote sensing the location of the time-varying tropopause break ***and then to quantify the contribution of STE to the mixing ratio of ozone in the mid-to-upper troposphere.***

Lagrangian mixing forecasts and analyses will be compared with remotely sensed observations of upper tropospheric specific humidity. Regions of significant mixing are hypothesized to occur along the gradient in specific humidity, where the flow is undergoing elongation (scale contraction) and where tropopause folds penetrate under the jet and are directed against the water vapor gradient. These are also regions favored for upper-level subsidence and clear air turbulence. Previous work by the PI has shown that tropopause folding activity, an important component of STE, is correlated with these strong gradients in remotely sensed specific humidity.

In the context of Aura validation, the PI will use this opportunity to evaluate total column ozone and profiles of upper tropospheric humidity from the Ozone Monitoring Instrument (OMI) and Tropospheric Emission Spectrometer (TES) sensors. The specific humidity gradients derived from the GOES imagery during INTEX-B will be hypothesized to represent the location of the polar tropopause break where STE is favored to occur and where tropospheric (and total column) enhancements of ozone are expected. The PI will identify regions where these STE features should be clearly discernable in either/ or both aircraft and Aura datasets, and a composite set of observed and modeled measures of composition (ozone, water vapor), along with dynamical and thermodynamical measures of the of STE (e.g., potential vorticity, tropopause height, vertical lapse rate, etc.) will be assembled for these regions/flight segments. This will result in a unique data subset, a case study library of events that will be used for characterizing the chemical and dynamical signatures of STE, and may also be used to evaluate our ability to accurately model the atmospheric conditions in these important regions of the atmosphere.